ANALYSIS OF MOLYCORP'S MINE FACILITIES IMPACT ON HYDROLOGIC BALANCE AND DRAINAGE OF SURROUNDING AREA

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A. GENERAL

(a.) Location

Molycorp's mine is located along the north side of the middle reach of Red River, Taos County, New Mexico. Along its middle reach, Red River flows through a canyon with slopes both to the north and south. Elevations within the mine disturbed area range from near 7700 feet along the river to near 10,000 feet along the ridge line between Sulphur Gulch and Goat Hill Gulch. The mine area extends over approximately four square miles and is surrounded by the Carson National Forest. The mine is located in natural forest areas consisting mainly of pinion, juniper and pine at the lower elevations and fir, pine and aspen at the higher elevations. The Questa Ranger Station is located about two miles to the west of the mine entrance road and the Town of Red River is situated about five miles east of the mill area. A small motel and a few unoccupied cabins are present on a couple of acres of private land near the confluence of Columbine Creek and Red River. Otherwise the only development between the ranger station and the Town of Red River is Molycorp's mine and several forest service campgrounds.

(b.) Generalized Geology

The mine area is near the south rim of a large collapsed caldera on the western slopes of the Sangre De Cristo mountains. The oldest rocks in the area are a complex of Precambrian quartzite, amphibolite, and granite. Tertiary volcanic rocks, dominantly andesite, were erupted over the Precambrian rocks. Eruption of the lavas and silicic tuffs led to caldera collapse. The youngest group, tertiary granitic rocks, were intruded into the Precambrian and volcanic rocks late in the history of the caldera. Hydrothermal solutions, related to the younger granites, altered and sulphidized the country rocks, especially the volcanics. The principal ore deposits of the district were

products of the hydrothermal alteration. The hydrothermally altered rock areas are located mainly to the north of Red River.

A prominent visual feature along the middle reach of Red River are the large hydrothermal scars that have been developed by deep erosion of some of the altered rock areas. Molycorp's mine area is located primarily within and beneath two of the larger scar areas.

(c.) Brief History of Molycorp's Mining Activity

Molycorp's mining operations commenced about 1920. The initial mine was an underground operation. This underground mining operation consisted of the development of numerous adits along Sulphur Gulch, an intermittent tributary of the Red River. The mill, camp, and a later haulage adit were distributed along Red River canyon to the east of the confluence of Columbine Creek and the Red River. The original underground mine did not have a significant impact on the quantity or quality of Red River or the ground waters in the mine area.

In 1965 Molycorp's open pit mine was initiated in Sulphur Gulch. It was necessary to excavate large quantities of overburden to reach the productive ore bodies. Much of the overburden was hydrothermally altered rock surrounding the Sulphur Gulch scar area. The excavated overburden material was deposited in large piles at the heads of Goat Hill and Capulin canyons and along the north side of Red River Canyon. A significant portion of the piles were deposited over natural hydrothermal scar areas.

The open pit mine intercepts and abates the surface and shallow ground water drainage from Sulphur Gulch which was one of the larger and more active scar areas.

In 1983 open pit mining was discontinued and Molycorp developed a new underground mine for extraction of ore - primarily from beneath the Goat Hill drainage area. The new underground mining zone is predominantly in non-altered, acid neutralizing rock formations.

Most of the present mine is substantially below the elevation of Red River. The mine is a block-caving operation that has resulted in a large conical subsidence area in Goat Hill Gulch. Since 1990, upper Goat Hill surface and shallow ground water drainage have been intercepted by this subsidence area.

In 1992 Molycorp constructed works which intercepts the drainage off open pit overburden piles and natural scar areas located at the head of Capulin Canyon. In 1993 additional catchment facilities were added to this system. The intercepted Capulin Canyon drainage is being discharged through a nearly horizontal bore hole to Goat Hill Gulch where it is intercepted.

During the past several years, Molycorp has developed facilities that have prevented the discharge of storm water from the mine area. The open pit mine and Goat Hill underground mine subsidence area capture all of the storm drainage from above these areas. Large berms have been constructed for interception of surface drainage from the drainage areas between Columbine Creek and the mill area and catchment basins have been constructed that retain the storm drainage from the lower sections of Capulin Canyon and Goat Hill Gulch.

(d.) Overview of Hydrology

The Red River, a major tributary of the Rio Grande, is the dominate element of the mine area hydrology. The Red River flows in a general westerly direction with a drainage area of 190 square miles on the western slopes of the Sangre De Cristo Mountains. The Red River rises from an elevation of 6600 feet at the confluence with the Rio Grande some 23 miles south of the Colorado border, to near the top of Wheeler Peak, New Mexico's highest mountain with an elevation of 13,162 feet. The upper reach of Red River is situated above and mostly to the east and south of the Town of Red River. The middle reach of Red River which includes the mine area, extends from the Town of Red River to the southern end of Sunshine Valley near the Questa Ranger Station. The lower four miles of Red River is in a deep gorge eroded into the volcanic rocks of Guadalupe Mountains and the Taos Plateau.

A USGS stream gaging station has been maintained near the Questa Ranger Station since 1913. Data indicates that there has been a significant decline in the flow of Red River during this period. This can be primarily attributed to the changes in forestation and undergrowth that has resulted from fire suppression. Because of the long term change, the flows for the period from 1951 to the present have been used herein for the determination of average annual and monthly stream flows.

The 1951-1993 average flow in Red River is 46.59 cfs. Over 50% of the flow at the ranger station results from surface and regolith discharge of melt of snow fall accumulated during the winter months. Most of the balance of the river flow results from discharge of snow melt water that has percolated to the ground water aquifer. Summer precipitation in the water shed averages slightly more than winter precipitation. Most of the summer precipitation is, however, returned to the atmosphere by evaporation and evapo-transpiration. The amount of summer precipitation reaching Red River by surface and ground water flow constitutes a small percentage of the total river flow. The principal snow melt generally begins in late April. Peak river flow normally occurs in late May or early June. Residual direct flow from snow melt generally extends into September. The following are the 1951-1993 average monthly Red River flows at the ranger station.

Average Red River Flow

@ Questa Ranger Station 1951 - 1993

Month	Average Flow CFS	Month	Average Flow CFS
October	26.56	April	43.85
November	21.34	May	120.00
December	16.83	June	137.45
January	16.52	July	63.49
February	17.20	August	43.07
March	19.19	September	32.49
Average Winter	1961	Average Summer	73.39

Average Annual 46.50 cfs

The Red River drainage basin above the ranger station extends over 113 square miles. The average yield amounts to 0.41 cfs per square mile. The yield per unit area, however, varies widely depending primarily on winter precipitation distribution and elevation. The highest peak flood flow of 886 cfs was recorded on May 25, 1942. A peak flood flow of 709 cfs occurred on June 8, 1979. Minimum stream flows of less than 2 cfs are occasionally recorded during winter months as a result of freezing of the river flow.

Precipitation data and the use of regression formulae developed by Hearne and Dewey USGS - 1986, indicates the following approximate values for the Red River drainage area:

Elevation	Winter Precip.* Inches	Annual Yield CFS Per Sq. Mile
7-8000'	5.50	0.035
8-9000'	7.61	0.113
9-10,000'	9.72	0.274
10-11,000'	11.83	0.556
11-12,000'	13.94	1.003
12-13,000'	16.05	1.666

*October thru April

Approximately 55% of the Red River drainage area above the ranger station, is above an elevation of 10,000 feet. This area, however, provides nearly 80% of the Red River flow.

Molycorp's mine and overburden disposal areas are located principally in the Sulphur Gulch, Goat Hill Gulch and Capulin Canyon drainage areas along the north side of Red River. The total of these drainage areas is 7.03 square miles. The average elevation of these drainage's is 9,000 feet and only about 0.5 square miles is above 10,000 feet. The calculated average yield from these drainage's is 1.3 cfs. This is less than 3% of the Red River flow at the ranger station.

There are no perennial streams from the mine area. Before development of the open pit mine it is probable that occasionally some surface flow reached the river from sulphur Gulch. Mine development and storm drainage control facilities eliminate surface discharge even though precipitation has been significantly above average.

B. FACILITIES IMPACT ON HYDROLOGIC BALANCE

The major impact of Molycorp's mining operation on the hydrologic balance of the mine area, results from the diversion of water for the transportation of tailings from the mill to the tailings disposal ponds located west of Questa. The tailings are transported through two 14 inch diameter rubber lined pipe lines. Water is added to the tailings to produce a slurry that will readily flow through the pipe lines. The slurry normally contains 38% tailings solids by weight. The nominal full production capacity of the mill is 18,000 tons of ore per day. The ore generally contains about 3% moisture by weight. At a milling rate of 18,000 tons per day, approximately 10 cfs of water is diverted to provide the slurry.

Water for tailings transportation is obtained by direct diversions from the river, from wells and from water pumped from the mine. From 1966 through 1992, total diversions have averaged 6.00 cfs or about 14% of the Red River yield above the ranger station. The direct river diversions and the well supply each provided about one-half of the total diversion. Water pumped from the mine amounted to less than 5% of the total.

Approximately 80% of the water diverted in the mine area is returned to the Red River at the tailings pond. This return water is monitored by the facility NPDES permit.

(a.) Direct River Diversions

The direct diversions are made from the river in the mill area. The diversion works consist of a small stilling basin on the bank of the river across from the mill referred to as the "log dam". The diversion includes a gated inlet structure and a gravity flow pipe line to the mill. Although the river diversion system has a capacity of approximately 6 cfs; actual diversions have generally amounted to 4 cfs or less. In particular, river diversions are significantly reduced or suspended during the low flow winter month

period. Diversions during low river flow periods are purposely reduced to maintain a significant downstream flow in the river.

(b.) Well Water Supply

Molycorp has four wells which produce a large percentage of the mines water supply. Two of the wells are located in a significant alluvial basin along Red River in the mill area. The other two wells are located in another river bed alluvial basin in Columbine Park located a few miles downstream of the mill area. These alluvial basins have the capability of yielding large quantities of water. The mill wells have capacities of between 1000 and 1500 gpm each. The yield of the Columbine wells also ranges from 1000 to 1500 gpm each depending on the water level in the alluvial aquifer

Several irrigation ditches divert water from Red River near and downstream from the ranger station. There has been no reports of shortages of water for these irrigation diversions or other purposes.

(c.) Mine Water

Most of the present underground mine is below the river level. The mine, however, produces a fairly small quantity of water because of the generally low permeability of the bedrock formation. During the underground mine development, pumpage ranged up to about 600 gpm. A significant portion of this yield was probably derived from released pore and trapped vein water. During the latter years of mine operation, the water yield declined and trended toward stabilization at about 200 gpm. Drainage into the mine through the cave from surface and shallow ground water from the upper reaches of Goat Hill Gulch and Capulin Canyon, may increase the long term water yield to about 300 gpm (0.67 cfs).

Water pumped from the mine is normally part of the water supply for the tailings slurry. The relatively small amount of pumped mine water does not significantly reduce the flow in Red River.

(d.) Sulphur Gulch

Before mine development, a portion of the precipitation falling on Sulphur Gulch, was discharged to the Red River. Development of the open pit resulted in the interception of drainage from the upper reach of Sulphur gulch and discharge of this drainage into the open pit. The open pit drains into the underground mine. The open pit, therefore, results in relocation of the discharge point for Sulphur Gulch drainage. The average drainage discharge of the upper Sulphur Gulch area is on the order of 0.15 cfs. Pre-open pit mine surface and shallow ground water discharge from upper Sulphur Gulch was very acidic and of extremely poor quality. Diversion of the drainage through the mine results in neutralization of the acidity and significant improvement in the quality of water being discharged to Red River.

(e.) Goat Hill Gulch and Capulin Canyon

Pre-open pit mine drainage from these areas was discharged through the shallow aquifer with occasional surface water flow. Such drainage was of very poor quality because of the hydrothermal scars and extensive areas of naturally altered rock. The amount of natural drainage from these basins would be on the order of 0.26 cfs from Goat Hill and 0.31 cfs form Capulin Canyon.

During development of the open pit mine, overburden was placed in piles in the upper reached of Goat Hill Gulch and Capulin Canyon.

Underground mining resulted in the development of a large, deep conical subsidence area in the bottom of Goat Hill Gulch. Surface and shallow ground water flow from the Goat Hill pile and the natural scar areas above the subsidence area flow into the subsidence zone and through the underlying fractured rock into the mine. This water is extracted from the mine with other mine developed water.

In 1992 and 1993 Molycorp constructed works to intercept the drainage from below the toe of the dump in Capulin Canyon. The intercepted drainage is being piped through a nearly horizontal borehole to Goat Hill Gulch where it flows to the cave. The average flow of water diverted from Capulin Canyon in about 35 gpm. A similar quantity of

surface flow from Goat Hill Gulch is intercepted by the subsidence area. In addition, the subsidence zone also intercepts some shallow ground water flow in Goat Hill Gulch. Ground water flows in Goat Hill Gulch below the subsidence and downstream of the catchment works in Capulin Canyon continue to flow to Red River. The areas below these points have not been impacted by mine development.

The relatively small quantity of water intercepted by the cave has a minuscule affect on the flow in red River. The diversion of acidic drainage from the natural scar areas above the subsidence area catchment system is beneficial relative to the quality of Red River water.

(f.) Other Mine Related Hydrological Impacts

The natural drainage from the mine area exclusive of upper Sulphur Gulch, Goat Hill Gulch and Capulin Canyon, averages on the order of 0.6 cfs. Several overburden piles were constructed in these areas during development of the open pit mine. These are mainly located in Spring Gulch and along the mountain slope on the north side of Red River between Sulphur Gulch and Goat Hill Gulch.

(g.) Storm Drainage

Intense thunderstorms frequently occur in the area during the summer months. These storms often result in short duration high discharges of drainage to Red River. Occasionally the precipitation results in significant mud flows from below the hydrothermal scar areas.

Molycorp has developed facilities that have prevented the surface discharge of storm water from the mine area during the past several years. The open pit mine and Goat Hill subsidence area capture all of the storm drainage from above these areas. Large berms have been constructed for interception of surface drainage from the drainage areas between Columbine Creek and the mill area and catchment basins have been constructed that have retained the storm drainage during the past several years from the lower sections of Capulin Canyon and Goat Hill Gulch. Storm drainage from the mine and mill area is regulated by the facility NPDES permit.

C. SUMMARY

(a.) Natural drainage from Molycorp's mine area averaged about 1.3 cfs which is less than 3% of the 46.6 cfs average yield of Red River above the ranger station.

(b.) The major impact of Molycorp's operations on the hydrological balance of the area results from diversion of water from Red River for the transportation of tailings. Such diversions have averaged 6 cfs or about 14% of the average yield of Red River above the ranger station. Approximately 80% of the water diverted is returned to Red River at the tailings disposal ponds located several miles downstream from the mill area. These discharge is regulated by the facility NPDES permit. The diversions mainly reduce the flow in Red River during periods of high river flow.

(c.) Development of the open pit and diversion of drainage into the mine via the subsidence in Goat Hill Gulch have resulted in a small reduction of direct drainage to Red River. The diverted water is very poor in quality because it originated from natural altered rock formations and hydro-thermal scars. The diversion of such drainage is beneficial to the quality of the water in Red River.

(d.) The apparent hydrological impact from other plant areas is minor relative to both Red River flow and water quality.

(e.) Storm drainage catchment facilities developed by Molycorp have prevented surface storm water discharges and related sediment transportation from the mine area to Red River.